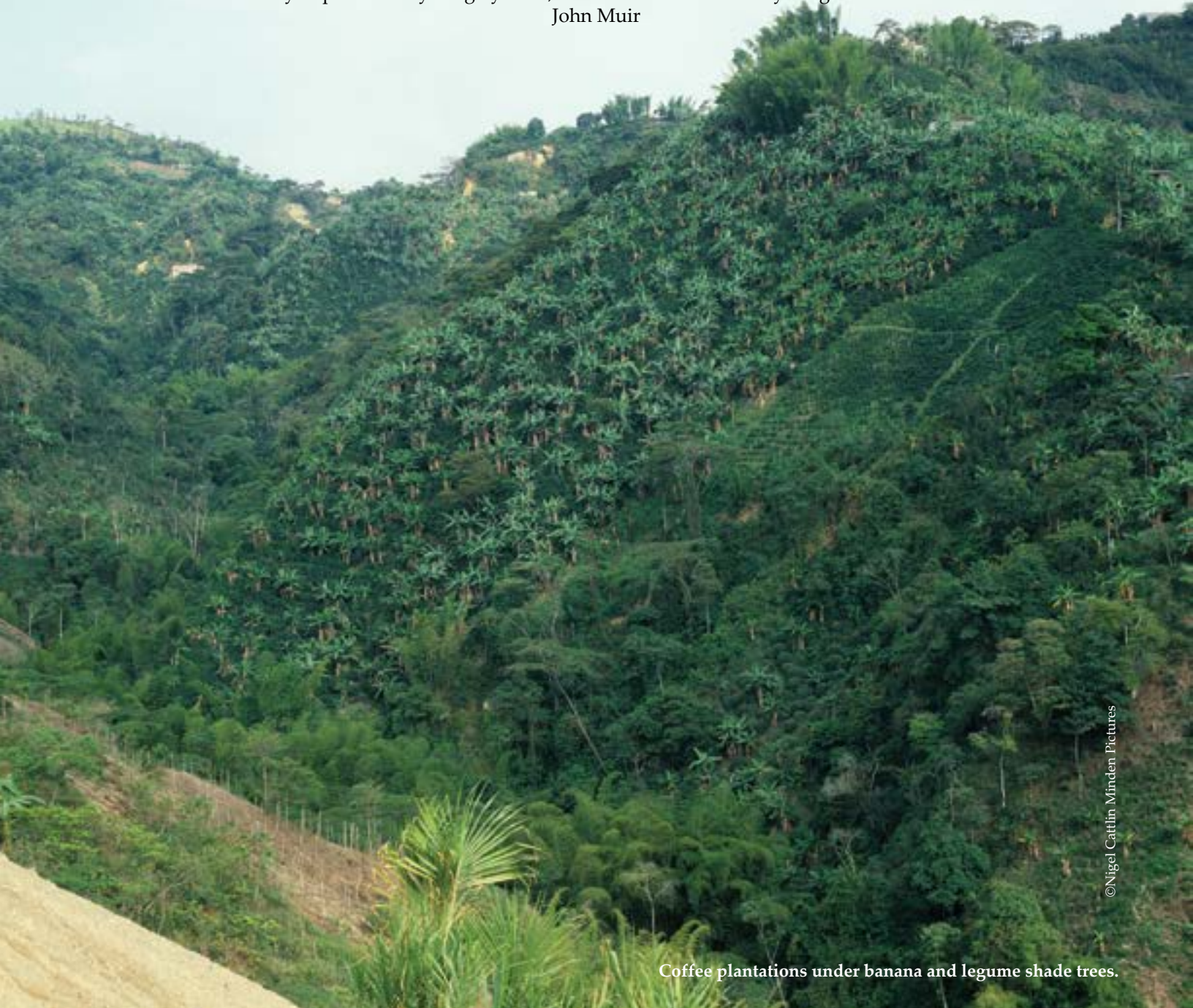


ORCHIDS AND COFFEE: GROUNDS FOR ALARM

CAROL SIEGEL

“When we try to pick out anything by itself, we find it hitched to everything else in the Universe.”

John Muir



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Coffee plantations under banana and legume shade trees.

MY GRANDDAUGHTER AND I were lamenting the sad fate of the Great Barrier Reef while we sat in my kitchen and drank our morning coffee from china cups (no Styrofoam here, no sir). She and I are keen advocates of taking care of our beautiful planet and all its incredible plants and animals. Imagine our dismay when we read in our morning newspaper that just by drinking a cup of coffee, even in a reusable cup, we were posing a significant risk to the biodiversity of Earth—and our beloved orchids. Who knew that with every casual sip, orchids were paying a real ecological price for our caffeine fix!

We are not the only ones addicted to coffee; we are not the only ones threatening orchids with our innocent morning habit. More than 400 billion cups of coffee are consumed across the world each year. As many as 25 million families in the developing world survive by growing coffee, and millions more subsist by processing, roasting, and selling it. It is the second most important export in the world, trailing only petroleum in importance and shores up the economies of 81 countries. Coffee is cultivated across 11 million hectares (42,471 square miles) of land within the world's richest centers of biodiversity. How coffee is grown in these centers

of life makes a difference since coffee plantations often serve as the last refuge for a fantastic array of increasingly threatened orchids, birds, insects, and mammals in an increasingly deforested world.

Shade or Sun

Forty years ago, almost all coffee was grown under the shade of the rainforest. The coffee plantation had a forest-like feel and came as close as any farm to mimicking the natural forest. It was universally celebrated as a wonderful refuge for biodiversity, even if it was not as good as the rapidly disappearing original forest. It allowed native vegetation to persist, minimizing the agricultural impact of human interference. Life thrived there. Orchids found a home.

A recent worldwide transition to growing in the sun to increase coffee yields has led to massive deforestation with grave consequences for orchids. In Central America alone, the sun cultivation of coffee has led to a 2.5 million-acre (1,011,714 hectares) loss of forest. With coffee being grown in biodiversity hotspots, how coffee is cultivated matters. Since a great many orchids grow as epiphytes on the tall, mature trees, the loss of the forest quickly translates into the loss of orchids. Furthermore, the recent trend to stripping the orchids and other epiphytes from the remaining trees and shrubs in the coffee plantations (in the mistaken belief that they are parasites), has led to the decimation of many species.

Mary Gerritsen visited Chiapas, Mexico, recently on an Orchid Conservation Alliance expedition and reported in this magazine that they came upon an area that was being cleared for a new coffee plantation and the scene was of utter devastation with huge trees lying on the ground, their epiphytic flora, bromeliads, and orchids, dying in front of their eyes.

In other locations where large remnant trees are spared to provide shade for young coffee plants, many orchids are found and include *Laelia superbiens*, species of *Mormodes* such as *Mormodes tuxtlenensis*, *Prosthechea* species such as *Prosthechea radiata*, and species of *Trichocentrum*, *Oncidium*, and *Encyclia*. The preservation of tall remnant trees seems to make a difference for the conservation of these orchids.

A few kilometers from the capital of Chiapas lies Cerro Brujo, a small mountain ridge, shrouded by dense fog. It is a center of extraordinary orchid richness as a result of being a natural biological corridor that connects both north-south and east-west orchid species movements and migrations. The traditional coffee plantation grown in the shade of tall trees preserves 61.3% of the orchids in the area, and 16 orchid species are only found ONLY there. The area contains nine endangered species as classified under CITES and Mexican law. *Phragmipedium humboldtii* var. *humboldtii* and *Rossioglossum williamsianum*, the former critically endangered and the latter declared functionally extinct, are found in this area. Recently, some coffee growers



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Coffee plantation without shade trees.



©John Varigos

Laelia superbiens



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Virgin forest in Brazil next to cleared land with a sun coffee plantation.

have started shifting to sun-grown coffee that requires the complete removal of all trees and plant life with catastrophic consequences to the cloud forest.

Mexico is not the only country where the conversion to sun or unshaded coffee farms has meant danger to orchids. Author Christopher Bacon laments:

From my own research in Nicaragua and other studies throughout the region, we may also know there are hundreds of orchids (likely thousands of species of orchids and other plants that grow on trees) conserved in the shade trees above the coffee, and nearly all the orchids are endangered. The trees, the biomass, and all the associated biodiversity directly linked to shade trees are lost with the conversion from shade to sun coffee.

Ethiopian Coffee Takes Over the World

Ethiopia is the birthplace of coffee. Arab and European traders introduced the beverage to Western Europe in the 1500s, and Dutch traders introduced it to the New World in 1723. Since then, it has become the favorite drink in the world.

Ethiopia is the only natural habitat in the world for the genetically diverse wild population of coffee. When native coffee shrubs grew under the natural forest canopy a vast array of endemic animal and plant species survived. With human modification into a “semi-forest

system,” 60% of the native species persisted. In intensively managed unshaded coffee farms, there are only 26% of the native species preserved. Today, only 10% of the original vegetation persists in this East African biodiversity hotspot, an area with 75% endemism in vascular plants. When endemic plants disappear in Ethiopia, they no longer exist. Today, only 5% of the coffee in Ethiopia is produced under native tree canopies, 10% is grown in semi-wild systems, and 85% is produced in so-called plantation systems. While coffee agroecosystems traditionally protected significant fractions of woody tree diversity, there was at least 34% loss of old-growth tree species in coffee farms with an additional loss of at least 37% if intensified to large scale coffee plantations. Added to the loss of big trees is the increasingly fragmented nature of the remaining trees, which limits pollinator and seed movements and may decrease genetic variety. Big trees matter. Small trees matter, too. These are the trees where orchids live. Felling trees threatens orchids.

Why Grow Coffee in the Sun Rather Than the Shade?

Many of the new coffee growing regions like Vietnam, Thailand, and Indonesia, where coffee growth is dramatically expanding, have entered the market with only unshaded coffee. Moreover, based on the nine



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Mormodes tuxtlensis



©Eric Hunt, grown by White Oak Orchids

Maxillaria densa

Latin American countries for which there is data from 1990 to 2010, most countries decreased the amount of land under shade. With a broader comparison of 19 countries for which we have 2010 coffee farm figures, data showed 41% had no shade, 35% had sparse shade, and 24% had traditional diverse shade. In 1996, 43% of all coffee areas surveyed were cultivated in traditional shade, so this is a loss of about 20% of shaded farms since then. Alarmingly, between 2000 and 2009, coffee growing regions in Costa Rica experienced a 50% loss of the coffee shade trees.

What happened? Why did the world suddenly decide to chop down trees and let in the sun? It is all a matter of economics. Governmental agencies told farmers that the best way to make money was to eliminate shade. Sun-coffee was supposed to increase yields while shade was supposed to decrease yields.

Growing coffee rarely makes a farmer rich. Huge swings in coffee prices, devastating fungal infections, and insect invasions, as well as uncertain climatic events such as hurricanes and droughts, make the life of the smallholder farmer difficult. The farmer is in the business of supporting his family and not in the business of supporting biodiversity. His eye is on the biggest yield and the greatest profit. Governmental agencies began pushing the idea that farmers would make more money if they cut down their tall forest trees and eliminated shade from their farms. The new farms, known as modern plantations or sun farms, increased in numbers in the 1970s. It is estimated that almost half of the area under coffee production in northern Latin America had been converted to sun-coffee by 1990, with 15% converted in Mexico but 60% in Colombia.

Modernization includes new, high-yield strains and the use of massive amounts of agrochemicals like fertilizers and pesticides. It includes few plants, if any, in the canopy above the coffee, and more coffee plants per hectare. It was hoped this change would combat fungal infections that have plagued coffee growers and governments for generations, particularly coffee leaf rust (*Hemileia vastatrix*) since less shade would mean less moisture on the plant and less fungal infections.



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Prosthechea radiata



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Pustules of coffee rust on the underside of a coffee leaf.



©Ron Parsons, grown by Todd Kennedy

Rossiglossum williamsianum 'Chestnut Clown'

Governmental agencies gave attractive incentives for cutting down the forest. Yield-focused coffee research institutes were created in the 70s and 80s. Procafe in El Salvador, AnaCAFE in Guatemala, ICAFE in Costa Rica, and IHCAFE in Honduras promoted the reduction and removal of shade cover. They created programs that included free or subsidized agrochemicals, training, and economic incentives. ICAFE promoted heavy use of fertilizers, nematicides, foliar feeders, and fungicides. The use of nematicide, one of the most toxic agrochemicals, exceeded more than 1700 metric tons in Costa Rica alone. INMECAFE, the Mexican national coffee organization, vigorously promoted large plantation monocultures that pushed the conversion from highly diverse coffee farms with multiple layers of trees to coffee monocultures with species of just one genus of shade tree, *Inga*, or no shade at all.

USAID launched a program called PROMECAFE, an acronym in Spanish for Coffee Improvement Project, in Costa Rica. Between 1978 and 1997, USAID established at least eight projects aimed at increasing coffee technology in Central America and the Caribbean. Over the course of 19 years, USAID funneled nearly 81 million dollars into these projects aiming to affect more than 300,000 hectares (1,200 square miles) of coffee and half a million regional producers. The disaster of forest removal and sun-growing did not just happen. Farmers were bribed and cajoled into changing.

Does the Removal of Shade Increase Yield?

Yes and no. Farmers believe that it does, but studies have shown contradictory results. Some studies showed a significant INCREASE of 10-30% in coffee yields after shade tree removal or pruning, but others found yield improvement or better grain quality with MORE shade. Others found NO difference between shade and non-shade coffee.

Still, others found a hump-shaped relationship with the highest yields produced at intermediate light levels. Analyzing the effect of shade on multiple yield-reducing factors such as weeds, disease, and pests, one author concluded that coffee yield is optimum between 35% and 65% shade.

Soto-Pinto (2000) found that in Chiapas, Mexico, yield was highest at shade cover between 30 and 45%. Shade cover and yield were maintained up to 48%, but yield declined when shade was more than 50%.

The Advantages of Growing Under Shade

In recent years, governments and coffee organizations have suddenly realized that it might not have been a great idea to change coffee farms and let in the sunshine. It turns out that the disadvantages outweigh the advantages of growing under sun. Not only does retaining large shade trees result in the preservation of



©Lourens Grobler

Dimerandra emarginata



©Eric Hunt, grown by Hanging Gardens

Oncidium poikilostalix (syn. *Sigmatostalix guatemalensis*)

high levels of biodiversity, but it also is good for the coffee bushes. The shade canopy intercepts solar radiation, wind, and rain resulting in a more stable environment for the crop, acting as a buffer against rain, wind, and temperature extremes that often harm the crop. Coffee bushes last longer under shade than they do with the stress of full sun, extending the productive life of the plants.

Coffee develops more slowly under shade, is less bitter, has higher sugar and lipid content with larger beans, and a more even roast. The taste is more delicious and nuanced, resulting in a better-tasting cup.

Coffee often grows on sloping mountainsides, where topsoil is easily washed away. The extensive root systems of large shade trees stabilize the ground and prevent soil erosion. Research shows that the trees don't compete with coffee for resources because they use different areas of soil. Trees provide habitat for natural beneficial insects and birds that reduce pests, and insecticides become unnecessary. The trees reduce weeds, and their leaves recycle nutrients and provide a nourishing humus layer that obviates the need for chemical fertilizers. Monocropping (just growing coffee) requires extensive use of chemical fertilizers and pesticides that wash away with heavy rain and pollute groundwater, rivers, and lakes. Higher levels of nitrates or phosphates in rivers and lakes can cause algae to bloom, depleting oxygen levels in the water and causing other organisms to suffer. A worst-case scenario occurred in Lake Atitlan in Guatemala where toxic algal blooms resulted in dead zones where nothing could live. Yikes!

Tending to sun coffee also requires a great deal of labor that is not necessary with more shaded farms. Farmers save money if they don't need to pay for agrochemicals or outside labor. The cost to produce one kg of coffee in 1996 was \$1.24 for modern (sun) coffee, \$1.14 for semi-modern, and \$0.85 for traditional shade coffee that may mitigate the effect of a possibly lowered yield.

In a time of frightening climate change, the trees take carbon dioxide out of the air and use it during

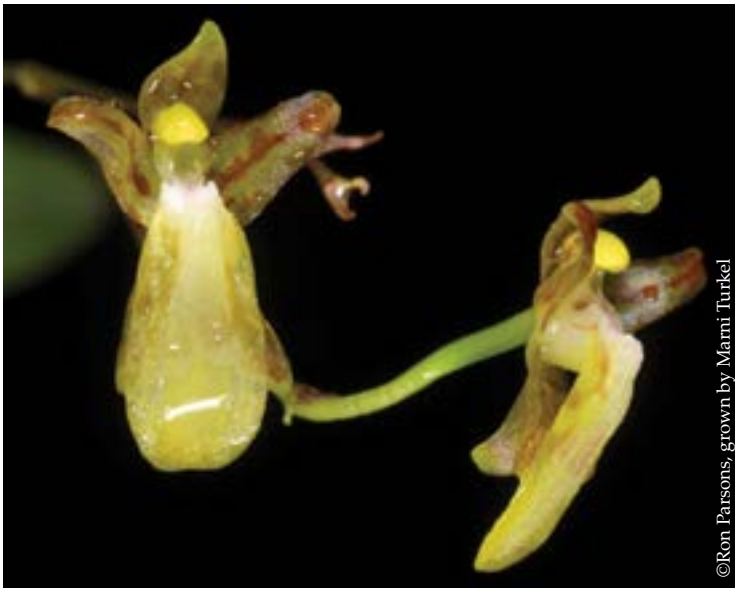
photosynthesis. The carbon is then stored in long-lived plant tissues in the tree so that the tree acts to sequester greenhouse gases from the air, which has a positive effect on climate change. Big trees buffer extremes of temperature and mitigate the impacts of post-hurricane landslides that are more frequent with increasing temperatures and more intense storms.

It is thought that coffee production is exceptionally vulnerable to climate change. Higher temperatures are thought to impact flavor negatively. Climate change leads to a loss of areas that are suitable for growing the more desirable Arabica coffee, which accounts for



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Erycina pusilla



©Ron Parsons, grown by Mami Turkel

Leochilus labiatus

62% of production. Its temperature range is 15–24°C (59–75°F), and as temperatures on Earth rise in the coming decades, coffee will have to shift to higher latitudes and higher altitudes. Bunn et al. 2015 predicted that the global area suitable for coffee production would be reduced by 50% by 2050. The average temperature is predicted to increase by 2–2.5°C, and coffee will need to move upslope by 300–400 meters (984–1,300 feet) to compensate. Tilman et al. 2001 estimated that a billion hectares of forestland will be converted to agriculture by 2050. The shift in elevation will increase the pressure on forests and the environmental benefits they provide. If more sun-coffee plantations were converted back to shade, we would have better pest control and pollinator services, less erosion, cleaner water, and a fabulous habitat for birds, bats, bees, and, of course, orchids. Certainly, with our greater awareness of the ecological services that the forests supply, we should be more careful in the future with the destruction of this precious resource as coffee moves up the slope into still-pristine forest.

Twig Epiphytes: Small, Mighty, and Endangered

An interesting development in the disturbed environment of the coffee plantation is the habit of a group of usually small orchids restricted to the thin branches of coffee plants and surrounding shade trees. They have unique adaptations like protuberances of the cell wall, modified cells in the velamen of the root, and hooks on their seeds that allow them to take advantage of the smooth bark of the twigs. Called “twig epiphytes,” they require a lot of sunlight, low humidity, and low accumulation of minerals.

In constant danger of blowing or falling from the coffee bushes or trees, twig epiphytes have a high mortality of immature juvenile plants. To compensate for living on the edge, they have incredibly fast growth that allows them to reach sexual maturity by the age of one year. (In contrast, an epiphyte like *Dimerandra emar-*

ginata takes six to ten years to mature sexually.) This incredibly fast growth rate gives the twig epiphytes the greatest chance of reproducing before they fall off the twig or land with the broken twig on the ground or are snipped off in the annual pruning of the coffee bushes.

Erycina crista-galli and *Ercn. pusilla*, like all *Erycina* species, are twig epiphytes and grow abundantly in coffee plantations, aided by their rapid growth. The coffee bushes, pruned annually and replaced every four or five years, are home to these orchids that have evolved to live life at top speed and can specialize on this relatively ephemeral substrate with little or no competition from other orchids.

Coffee only came to Mexico 100 years ago. In the last ten years, there has been considerable concern over changes in coffee management, most recently the practice of periodic removal of epiphytes to increase production known as “desmusgue.” Farms, where epiphytes are not removed, are considered “unmanaged,” which is thought to be a bad thing. This process is proving detrimental to the survival of these orchids. Systematic removal of epiphytes (whether bromeliads, ferns, or mosses) destroys many scarce, localized orchids. Studies estimate that this practice will result in the demise of the twig epiphytes in 30 years, and the removal of moss from trees will make it difficult for orchid seeds to germinate. Limited tree pruning and the preservation of the epiphytes on trees and bushes should encourage orchid species richness.

Oncidium poikilostalix (syn. *Sigmatostalix guatemalensis*), a new orchid for Mexico, occurs in small populations in two locations in coffee plantations in Soconusco, a region in the southwest corner of the state of Chiapas in Mexico. The low-impact maintenance style of these plantations results in favorable conditions that promote the growth of smaller orchid species like *Erycina* species, *Leochilus* species, *Scaphyglottis livida*, and *Ornithocephalus inflexus*, all adapted to growing on coffee bushes.

One interesting article suggested the promotion of controlled harvesting of thousands of epiphytes annually for sale would get farmers to value epiphytes for their commercial potential. If epiphyte removal is thought to increase yield, appropriate epiphyte management could preserve yield by removing SOME epiphytes each year, adding to a farmer’s income.

Certification: Putting Your Money Where Your Mouth Is

Since the farmer is in the business of making money, we would be wise to reward him for growing in ways that fulfill our ecological goals AND his economic goals. Coffee certification programs now offer the ability to accomplish both these goals. Coffee certification programs aim to combine conservation with the economic well-being of the coffee farmer by rewarding him with a premium price for growing in environmentally desirable ways. The consumer pays a premium for

coffee grown with certification and becomes a partner in conserving biodiversity.

Although not all of us think of the social and environmental effects of our morning fix, a significant number of coffee drinkers in the specialty market do. For many of us, knowing that the land and people are treated well, that the orchids and other plants and animals are being protected, is a valuable part of the coffee-drinking experience. We will pay more for this.

As Daniel S. Cooper, spokesman for the Rogers Family Company, says:

Our shared challenge is to draw the connection between the activities of the farms themselves—the choice to maintain the forest, to not hunt animals, to plant shade trees, to allow habitat corridors along streams—and the consumer who chooses to support the values evinced by these farms.

Certification is commonly Fair Trade, Organic, or Shade-Grown. Various organizations have certification standards and offer their certification such as the Rainforest Alliance, Organics, and the Smithsonian Bird-Friendly certification. They are invaluable systems for providing coffee producers with incentives.

Orchid lovers should be most concerned with the “shade-grown” certification, but there is no official definition for shade-grown coffee so farms with minimal shade cover can claim to produce “shade coffee.” The Smithsonian Migratory Bird Center developed the only authentic shade-grown certification. The criteria include a canopy at least 12 meters high with the dominant tree species being native, a minimum of 40% shade cover even after pruning, and at least two strata or layers of vegetation made up of at least ten woody species dispersed throughout the production area. Pruning of the overstory and the removal of epiphytes is discouraged, and buffer zones are encouraged. Additionally, the coffee must be certified organic, meaning no pesticides were used in the preceding three years. Bird-Friendly certification has the most robust shade standard of any coffee certification. It is a pass/fail system, and all the criteria must be met. Bird-Friendly certification lasts three years, and no minimum price premium is set, but it can be used to negotiate a higher price, usually 5-10 cents a pound. Growers also receive a premium for the organic part of the certification. There is no certification fee, although growers pay for audits. Only the coffee certified by the Smithsonian Migratory Bird Center can be called Bird Friendly and is now the gold standard for shade-grown coffee.

Fair Trade coffee, which is concerned with the fair treatment of coffee workers, offers a minimum price per pound with an additional premium if the coffee is also certified organic. Neither organic nor fair trade coffee is related to growing under shade, and standards regarding wildlife are relatively generic. However, both Fair Trade and Organic certifications have been shown to provide farmers with more access to credit and technical support.



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Scaphyglottis livida

The Rainforest Alliance and another certification organization, UTZ, merged in 2018 and is now named the Rainforest Alliance. Their certification is not exclusively environmental but includes fair treatment of workers. Its standards for shade-grown coffee are not as strict as those of the Bird-Friendly certification, but it is undoubtedly a step in the right direction. Shade management criteria are open to interpretation and include shaded monocultures which in no way resemble the forest environment. The Rain Forest Alliance states that biodiversity is conserved in coffee farms with an “adequate number per hectare of suitable shade trees,” and coffee farms must ensure that “the tree community on the cultivated land consists of a minimum of 12 native species per hectare on average, the tree canopy comprises at least two strata, or stories, the overall canopy density on the cultivated land is at least 40%.” In “areas where the original natural vegetation is not forest, such as grasslands, savannas, scrublands or shrublands, must dedicate at least 30% of the farm area for

conservation or recovery of the areas' total ecosystem." Of the different kinds of coffee growing situations, all but full sun qualify as shade including the shaded monoculture which does not preserve any forest trees. The criteria for shade are much less stringent than that of the Smithsonian. Criteria for native vegetation cover are not required for six years, and it is important to note that Rainforest Alliance certified coffee might not be shade-grown and has no organic requirement. It has a certification program using standards of the Sustainable Agriculture Network that they apply to other crops as well. It deals with an array of ecosystem issues such as water conservation, as well as the use of chemicals, community relations, and treatment of workers. Certification is awarded based on a score for meeting a minimum number of an array of criteria. Only 30% of the beans have to be certified to meet the Rainforest Alliance standards.

Companies are starting to value sustainable coffee practices. The Rainforest Alliance is one of the largest mainstream coffee certification schemes, having partnered with Sara Lee, Kraft, and Nespresso and has the largest share of sustainable coffee roasters in the world. The association with "sustainable practices" enhances corporate reputation, and companies like Starbucks and Ben and Jerry's have become interested in associating with sustainable coffee practice. For example, Ben and Jerry's offers the new Coffee for Change ice cream flavor using shade coffee. In 2007, 10% of the coffee sold worldwide had at least one certificate of sustainability. Of the three coffee certification programs, Fair Trade, Organic, and Shade Grown, Shade Grown has the lowest market share, with 10.5% of all exports of certified coffee.

The consumer does not have to be alone in paying for sustainable practices. Shade-grown coffee provides many important ecological services from protecting pollinators to purifying water and preventing soil erosion. Governments can support and subsidize these ecological services with payments to farmers who operate in a way that protects the climate, biodiversity, pollinators, water, and soil.

I went online and searched for "shade-grown coffee." Not surprisingly, there are many sellers of this specialty coffee product. I went to Sprouts and found, in addition, many coffee brands that were certified in different categories at prices as high as \$19.99 a pound. The question remains whether consumers will pay the price for increased diversity. Coffee has emerged as a test case in whether people will put their money where their mouth is to save the planet and its life forms.

I never considered whether my morning coffee in any way affected my beloved orchids. Now that I know that it does, I have been buying shade-grown coffee. To my delight, it has a richer flavor, more like caramel, with a smooth finish that I love. Try it. I think that you will love it and agree with me that it is a small thing to do that might make a big difference.*



Ornithosephalus inflexus

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